

## Claims

- [c1] 1. A combustor for a turbine comprising:
- a combustor liner including a plurality of circular ring turbulators arranged in an array axially along a length defining a length of said combustor liner and located on an outer surface thereof;
  - a first flow sleeve surrounding said combustor liner with a first flow annulus therebetween, said first flow annulus including a plurality of axial channels (C) extending over a portion of an aft end portion of the liner parallel to each other, the cross-sectional area of each channel is one of substantially constant and varying along the length of the channel, said first flow sleeve having a plurality of rows of cooling holes formed about a circumference of said first flow sleeve for directing cooling air from compressor discharge air into said first flow annulus;
  - a transition piece connected to said combustor liner, said transition piece adapted to carry hot combustion gases to a stage of the turbine;
  - a second flow sleeve surrounding said transition piece, said second flow sleeve having a second plurality of rows of cooling apertures for directing cooling air from com-

pressor discharge air into a second flow annulus between the second flow sleeve and the transition piece, said first flow annulus connecting to said second flow annulus;

wherein said first plurality of cooling holes and second plurality of cooling apertures are each configured with an effective area to distribute less than 50% of compressor discharge air to said first flow sleeve and mix with cooling air from said second flow annulus.

[c2] 2.The combustor of claim 1, wherein a first row of said plurality of rows of cooling apertures in said second flow sleeve is located proximate an end interfacing said first flow sleeve.

[c3] 3.The combustor of claim 2, wherein said first row of cooling apertures allow said compressor discharge air to enter said first flow annulus prior to entering said second flow annulus.

[c4] 4.The combustor of claim 3, wherein said first row of cooling apertures are located on an angular portion of said second flow sleeve directing air flow therethrough at an acute angle relative to a cross airflow path through said first and second flow annuli.

[c5] 5.The combustor of claim 4, wherein each cooling aper-

ture includes a diameter of about 0.5 inches.

- [c6] 6.The combustor of claim 1, wherein said first plurality of cooling holes and second plurality of cooling apertures are each configured with an effective area to distribute less than a third of compressor discharge air to said first flow sleeve and mix with a remaining compressor discharge air flowing from said second flow annulus.
- [c7] 7.The combustor of claim 1, wherein said liner is a wrought alloy liner.
- [c8] 8.The combustor of claim 1, wherein the cross-sectional area of each channel uniformly decreases along the length of the channel from an air inlet for admitting air into each channel to an air outlet by which air is discharged from the liner end of the liner.
- [c9] 9.The combustor of claim 8, wherein a height of each channel uniformly decrease along the length of the channel from the air inlet end to the air outlet end of the liner, thereby to reduce thermal strain occurring at the aft end of the liner so to prolong the useful life of the liner and reduce the amount of air needed to flow through the liner to affect a desired level of cooling in the transition region.
- [c10] 10.The combustor of claim 9, wherein height of the

channels substantially decreases from the air inlet end to the air outlet end of the liner.

[c11] 11.The combustor of claim 10, wherein the height of the channels decreases by at least 40% from the air inlet end to the air outlet end of the liner.

[c12] 12.The combustor of claim 1 further comprising a plurality of flow catcher devices, each flow catcher device comprising a scoop fixed to an outside surface of said second flow sleeve about a portion of a respective one of said cooling apertures and having an open side defined by an edge of the scoop lying in a plane substantially normal to said outside surface and arranged to face a direction of compressor discharge air flow, such that said flow catcher devices redirect compressor discharge air flow through said second flow sleeve and onto said transition piece.

[c13] 13.The combustor of claim 12, wherein said plurality of flow catcher devices are welded to said second flow sleeve.

[c14] 14.The combustor of claim 12, wherein each flow catcher device has an open side facing a direction of compressor discharge air flow, such that said flow catcher devices redirect compressor discharge air flow

through said second flow sleeve and onto said transition piece, said plurality of flow catcher devices disposed with at least one row of some of said cooling apertures.

[c15] 15. The combustor of claim 14, wherein each flow catcher device is arranged along opposite side panels defining said second flow sleeve, substantially adjacent corresponding side panels defining said transition piece.

[c16] 16. A turbine engine comprising:  
a combustion section;  
an air discharge section downstream of the combustion section;  
a transition region between the combustion and air discharge section;  
a turbulated combustor liner defining a portion of the combustion section and transition region, said turbulated combustor liner including a plurality of circular ring turbulators arranged in an array axially along a length defining a length of said combustor liner and located on an outer surface thereof;  
a first flow sleeve surrounding said combustor liner with a first flow annulus therebetween, said first flow annulus including a plurality of axial channels (C) extending over a portion of an aft end portion of the liner parallel to each other, the cross-sectional area of each channel is one of substantially constant and varying along the

length of the channel, said first flow sleeve having a plurality of rows of cooling holes formed about a circumference of said first flow sleeve for directing cooling air from compressor discharge air into said first flow annulus;

a transition piece connected to at least one of said combustor liner and said first flow sleeve, said transition piece adapted to carry hot combustion gases to a stage of the turbine corresponding to the air discharge section; a second flow sleeve surrounding said transition piece, said second flow sleeve having a second plurality of rows of cooling apertures for directing cooling air from compressor discharge air into a second flow annulus between the second flow sleeve and the transition piece, said first flow annulus connecting to said second flow annulus;

wherein said first plurality of cooling holes and second plurality of cooling apertures are each configured with an effective area to distribute less than 50% of compressor discharge air to said first flow sleeve and mix with cooling air from said second flow annulus serving to cool air flowing through the transition region of the engine between the combustion and air discharge sections thereof.

cooling holes and second plurality of cooling apertures are each configured with an effective area to distribute less than a third of compressor discharge air to said first flow sleeve and mix with a remaining compressor discharge air flowing from said second flow annulus.

[c18] 18.The engine of claim 16, further comprising a plurality of flow catcher devices, each flow catcher device comprising a scoop fixed to an outside surface of said second flow sleeve about a portion of a respective one of said cooling apertures and having an open side defined by an edge of the scoop lying in a plane substantially normal to said outside surface and arranged to face a direction of compressor discharge air flow, such that said flow catcher devices redirect compressor discharge air flow through said impingement sleeve and onto said transition piece.

[c19] 19.The engine of claim 16, wherein a first row of said plurality of rows of cooling apertures in said second flow sleeve is located proximate an end interfacing said first flow sleeve.

[c20] 20.A method of cooling a combustor liner of a gas turbine combustor, said combustor liner having a substantially circular cross-section, and a first flow sleeve surrounding said liner in substantially concentric relation-

ship therewith creating a first flow annulus therebetween for feeding air to the gas turbine combustor, and wherein a transition piece is connected to said combustor liner, with the transition piece surrounded by a second flow sleeve, thereby creating a second flow first annulus in communication with said first flow first annulus; the method comprising:

providing a plurality of axially spaced rows of cooling holes in said flow sleeves, each row extending circumferentially around said flow sleeves, a first of said rows in said second sleeve is located proximate an end where said first flow sleeve and said second flow sleeve interface;

supplying cooling air from compressor discharge to said cooling holes;

configuring said cooling holes with an effective area to distribute less than a third of compressor discharge air to said first flow sleeve and mix with a remaining compressor discharge air flowing from said second flow annulus.

- [c21] 21. The method of claim 20, further comprising:  
forming a plurality of discrete ring turbulators arranged in spaced relationship on said outer surface of said combustor liner to enhance heat transfer, each ring turbulator comprising a raised rib in planform view of substan-



tially round or oval shape extending radially from said outer surface, defining a hollow region within said rib that is closed at one end by said outside surface of said combustor liner, said hollow regions adapted to create vortices in cooling air flowing across said outside surface of said combustor liner.

[c22] 22.The method of claim 20, further comprising:  
configuring said first flow annulus with a plurality of axial channels (C) extending over a portion of an aft end portion of the liner parallel to each other, the cross-sectional area of each channel is one of substantially constant and varying along a length of the channel.

[c23] 23.The method of claim 22, wherein the cross-sectional area of each channel uniformly decreases along the length of the channel from an air inlet for admitting air into each channel to an air outlet by which air is discharged from the liner end of the liner.

[c24] 24.The method of claim 23, wherein a height of each channel uniformly decrease along the length of the channel from the air inlet end to the air outlet end of the liner, thereby to reduce thermal strain occurring at the aft end of the liner so to prolong the useful life of the liner and reduce the amount of air needed to flow through the liner to affect a desired level of cooling in

the transition region.

- [c25] 25. The method of claim 20, further comprising:  
configuring a plurality of flow catcher devices, each flow catcher device comprising a scoop fixed to an outside surface of said second flow sleeve about a portion of a respective one of said cooling apertures and having an open side defined by an edge of the scoop lying in a plane substantially normal to said outside surface and arranged to face a direction of compressor discharge air flow, such that said flow catcher devices redirect compressor discharge air flow through said second flow sleeve and onto said transition piece.